

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 1 619 235 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

25.01.2006 Bulletin 2006/04

(51) Int Cl.:

C10M 169/04 (2006.01)

C10M 145/14 (2006.01)

B60K 17/00 (2006.01)

(21) Application number: **05254411.1**

(22) Date of filing: **14.07.2005**

(84) Designated Contracting States:

**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**

Designated Extension States:

AL BA HR MK YU

(72) Inventor: **Clague, Nicholas Paul**

Bracknell, Berkshire RG12 9YB (GB)

(74) Representative: **Cresswell, Thomas Anthony**

J.A. Kemp & Co.

14 South Square

Gray's Inn

London WC1R 5JJ (GB)

(30) Priority: **21.07.2004 GB 0416319**

(71) Applicant: **Afton Chemical Limited**

Bracknell, Berkshire RG12 2UW (GB)

(54) **Polyalkylmethacrylate polymer as filtration improver**

(57) Use of a C₁₂₋₂₀ polyalkyl methacrylate polymer as a lubricating oil additive such that the C₁₂₋₂₀ polyalkyl methacrylate polymer accounts for 0.1 to 0.3 % by weight of the finished lubricating oil, which use comprises the

addition of said C₁₂₋₂₀ polyalkyl methacrylate polymer to a lubricating oil based on mineral oil to improve the filtration of said lubricating oil based on mineral oil.

EP 1 619 235 A1

Description

[0001] The invention relates to the use of a composition as a lubricating oil additive to improve the filtration of oils based on mineral oils.

[0002] Wear is the loss of metal between surfaces moving relative to each other. Wear occurs in all equipment that has moving parts and if it continues, can lead to equipment malfunction. Lubricant compositions are commonly applied to the metal surfaces of mechanical equipment that features the movement and contact of metal surfaces, for example, in the rolling-sliding contacts of hard steel surfaces. This reduces wear and other damage such as micro-pitting (sometimes called "frosting", "greystaining" or "peeling") which can occur in rolling element bearings and most often on gear teeth, which can lead to significant practical problems such as scuffing, and even to tooth fractures of gears.

[0003] The primary function of a gear lubricant is to protect both gears and axles against micro-pitting, fatigue, scoring and wear and to provide a high degree of reliability and durability in the service life of gear equipment. In the automotive industry gear lubricants may also contribute to improving the fuel economy of vehicles by improving the axle efficiency.

[0004] A large number of dewaxing aids are commercially available for use as oil additives. One series of such aids is sold under the name Viscoplex®. Included in this series of dewaxing aids are Viscoplex® 9-144, Viscoplex® 9-300, Viscoplex® 9-303 and Viscoplex® 9-305, each of which is described as a viscous concentrate of polyalkyl methacrylate in a solvent-refined neutral oil. Each of these is for use in dewaxing oils as part of the refining process for producing mineral oil base-stock, and each is also said to have the properties of improving filtration speed and oil yield in the dewaxing process, improving the low temperature properties of the resulting base stock, improving the yield of dewaxed oil, increasing oil through-put, reducing the oil content in wax produced and reducing the risk of slack-wax formation on filters. Viscoplex 9-305® is used largely for the purpose of modifying the flow of crude oil through pipelines.

[0005] US 6,495,495 B1 discloses the use of a blend comprising from about 30 to about 70 % (preferably 50 %) of an alkyl ester polymer (preferably an ethylene-vinyl acetate copolymer) and from about 70 to about 30 % (preferably 50 %) naphthenic oil as a filterability improver.

[0006] Oil products based on mineral oil in the transportation industry generally contain levels of dissolved paraffins (waxes), which are soft and flexible. At low temperatures, these paraffins can begin to precipitate which causes an increase in the viscosity of the product, reducing its ability to flow. In certain diesel engines, for example those that feature a filter, this can also lead to blockages.

[0007] The present invention is based on the surprising appreciation that certain concentrations of a particular C₁₂₋₂₀ polyalkyl methacrylate polymer, such as may be obtained from RohMax under Viscoplex 9-305®, may be included in a lubricating oil based on mineral oil, such as a gear oil, with the result that a significant improvement in filtration performance is observed when the composition is used as an additive to the lubricating oil based on mineral oil.

[0008] Accordingly, the present invention provides for the use of a C₁₂₋₂₀ polyalkyl methacrylate polymer as a lubricating oil additive such that the C₁₂₋₂₀ polyalkyl methacrylate polymer accounts for 0.1 to 0.3 % by weight of the finished lubricating oil, to improve the filtration of the lubricating oil based on mineral oil. The C₁₂₋₂₀ polyalkyl methacrylate polymer may be used in the form of a composition comprising a mineral carrier oil. In a preferred aspect the invention relates to the use of a composition comprising a C₁₂₋₂₀ polyalkyl methacrylate polymer in a mineral carrier oil to improve the filtration of a lubricating oil based on mineral oil. Preferably the composition accounts for 0.2 to 0.5 % by weight of the finished lubricating oil. Typically, the composition comprises 40 to 50 % by weight of the C₁₂₋₂₀ polyalkyl methacrylate polymer and 50 to 60 % by weight of the mineral carrier oil. Preferably, the composition consists of about 45 % by weight of the C₁₂₋₂₀ polyalkyl methacrylate polymer and about 55 % by weight of the mineral carrier oil. The use according to the present invention results in a finished lubricating oil that exhibits a significant improvement in filtration performance.

[0009] The present invention also provides for a finished lubricating oil that results from use according to the invention as defined above, a composition for use according to the invention as defined above, a method of lubricating a metal surface comprising applying said finished lubricating oil to the metal surface, a gear or axle that has been lubricated as defined in said method, and an additive pack comprising a composition for use according to the invention as defined above.

[0010] In a preferred embodiment of the use according to the present invention the composition comprising the C₁₂₋₂₀ polyalkyl methacrylate polymer has a viscosity of 500 to 1000 mm²/s. More preferably, the composition has a viscosity of about 800 mm²/s (ASTM D4052) at 100 °C.

[0011] In one preferred embodiment the present invention provides for the use of a C₁₂₋₂₀ polyalkyl methacrylate polymer as defined above wherein the lubricating oil based on mineral oil is a gear oil. Accordingly, the finished lubricating oil that results from use according to the present invention is preferably for use in gear oil formulation applications.

[0012] In another preferred embodiment of the present invention, the finished lubricating oil that results from use according to the present invention meets the specification by Scania (STO 1:0). This specification requires that the oil to be tested is filtered through a 5 micron (pore size) cellulose membrane in the CETOP RP 124H test, wherein a minimum result of 90 % is required in stage 2 in order for the specification to be met. CETOP stage 2 gives a measurement of filterability and provides the ratio (expressed as a percentage) of the flow rates through the membrane at the end of and at the beginning of the test. A filtration measurement may also be expressed as a volume, wherein the volume

represents the amount of oil filtered over a given period of time. It should be noted that repeatability is not good (especially for particularly low or high viscosity fluids) and therefore for each experiment at least three runs are conducted. Accordingly, the finished lubricating oil that results from use according to the present invention exhibits a mean of at least 3 CETOP stage 2 test values of over 90 %. More preferably, this finished lubricating oil meets the specification by Scania (STO 1:0).

[0013] In the present invention the finished lubricating oil that results from the use according to the invention as defined above is for use as a lubricant. Preferably, it is a formulated gear oil lubricant composition, for instance for transmissions such as automobile rear axles and manual and automatic gear boxes. More preferably this gear oil composition is formulated to meet the specification by Scania (STO 1:0) for the rear axle and manual gear box of diesel engined automobiles.

[0014] Typical treat rates at which the C_{12-20} polyalkyl methacrylate polymer is used include 0.09 % and above such as 0.14 and 0.18 %. In another preferred embodiment of the use according to the present invention, the C_{12-20} polyalkyl methacrylate polymer is used at a treat rate such that it accounts for 0.1 to 0.2 % by weight of the finished lubricating oil. Typically, the C_{12-20} polyalkyl methacrylate polymer accounts for 0.1, 0.15 or 0.2 % by weight of the finished lubricating oil. More preferably, the C_{12-20} polyalkyl methacrylate polymer accounts for 0.15 or 0.2 % by weight of the finished lubricating oil. The optimum treat rate will vary according to the nature of the mineral base oil and may be determined on a case-by-case basis by use of the CETOP stage 2 test.

[0015] In another preferred embodiment the present invention provides for the use of a composition of the invention as defined above wherein the composition is used at a treat rate such that it accounts for 0.2 to 0.4 % by weight of the finished lubricating oil. Typically, the composition accounts for 0.2, 0.3 or 0.4 % by weight of the finished lubricating oil. More preferably, the composition accounts for 0.3 or 0.4 % by weight of the finished lubricating oil. The optimum treat rate will vary according to the nature of the mineral base oil and may be determined on a case-by-case basis by use of the CETOP stage 2 test.

[0016] In another preferred embodiment of the use according to the present invention the lubricating oil based on mineral oil is for automotive or industrial applications. In another preferred embodiment of the use according to the present invention, the lubricating oil based on mineral oil has a viscosity of 80W-90 or 85W-140. In another preferred embodiment of the use according to the present invention the lubricating oil based on mineral oil is a part synthetic base stock. In another preferred embodiment of the use according to the present invention the lubricating oil based on mineral oil comprises brightstock. Preferably, the lubricating oil based on mineral oil is Kuwait Petroleum Company, Respol YPF, Total, Esso or SAFOR base stock. More preferably, the lubricating oil based on mineral oil is a wax-containing base stock.

[0017] In another preferred embodiment of the use according to the present invention the lubricating oil based on mineral oil and/or the finished oil comprises a further additive, which further additive is added to the lubricating oil based on mineral oil or the finished lubricating oil prior to, simultaneously with or subsequently to the C_{12-20} polyalkyl methacrylate polymer.

[0018] The present invention also provides for a method of lubricating a metal surface comprising applying to the metal surface a finished lubricating oil of the present invention as defined above. Preferably the metal surface is that of a gear or axle. More preferably the metal surface is that of a gear or rear axle. Typically, the method comprises adding to and operating a transmission or axle a finished lubricating oil of the invention as defined above.

[0019] The present invention also provides for an additive pack comprising a C_{12-20} polyalkyl methacrylate polymer for use according to the invention as defined above. The additive pack is added to a lubricating oil based on mineral oil such that the C_{12-20} polyalkyl methacrylate polymer accounts for 0.1 to 0.3 % by weight of the finished lubricating oil. Preferably, the additive pack is added to the lubricating oil based on mineral oil such that the contents of the additive pack account for up to 15 % by weight of the finished lubricating oil. Typically, the additive pack is added to the lubricating oil based on mineral oil such that the contents of the additive pack account for 4 to 10 % by weight of the finished lubricating oil. Such an additive pack may comprise any oil additive known to a person skilled in the art that does not interfere with the performance of the C_{12-20} polyalkyl methacrylate polymer when used accordance with the present invention as defined above. Examples of appropriate additives are illustrated in the Examples below, wherein a composition of the invention as defined above for use according to the present invention is shown to work in a variety of blends with numerous different additives. Other appropriate additives that may be used in conjunction with the present invention will be evident to the person skilled in the art and include pour point depressants, anti-wear additives, anti-oxidation additives, anti-rust additives, dispersants, boronated dispersants, HiTEC 381 (a fully formulated gear package), viscosity index improvers, detergents and friction modifiers.

[0020] The composition for use according to the invention as defined above is preferably in the form of a concentrate. In another preferred embodiment this concentrate is combined with a dispersant. Suitable dispersants will be evident to the person skilled in the art.

[0021] The present invention additionally includes machines lubricated by the lubricating oil described above. Although the machine may be any machine for which the inventive lubricating oil would provide satisfactory lubrication, it is envisioned that such machinery would include gas engines, diesel engines, turbine engines, automatic transmissions,

manual transmissions, hypoid axles, and gear boxes. Furthermore, the present invention includes vehicles comprising the inventive oil soluble lubricant additive package described above.

[0022] Further, the present invention provides a method for lubricating moving parts of a machine comprising the step of: contacting at least one moving part with a lubricant comprising the oil soluble lubricant additive package described above. Although the method may be successfully employed on a wide variety of machines, it is envisioned that such machinery would include: gas engines, diesel engines, turbine engines, automatic transmissions, manual transmissions, hypoid axles, and gear boxes.

[0023] It is also useful herein that at least one dispersant used in the oil soluble lubricant additive package described above has a molecular weight of from about 1,000 to about 20,000 amu. In one embodiment the at least one dispersant is a maleic anhydride functionalized polyisobutylene polymer that has been reacted with a polyamine. Also the at least one dispersant can be a product of a Mannich reaction. It is further equally possible that the at least one dispersant is an ethylene-propylene type dispersant.

[0024] It is further preferred in one embodiment that the oil soluble lubricant additive package described above additionally comprise at least one component selected from the group consisting of: viscosity index improvers and pour point depressants.

[0025] The present invention also includes machines lubricated by the lubricating oil described above. Although the inventive lubricating oil can be used on a wide variety of machines, it is envisioned that the machines especially suited for lubrication include: gas engines, diesel engines, turbine engines, automatic transmissions, manual transmissions, hypoid axles, and gear boxes.

[0026] Additionally, the present invention includes vehicles comprising the oil soluble lubricant additive package described above.

[0027] A method for lubricating moving parts of a machine is also provided comprising the step of: contacting at least one moving part with a lubricant comprising the oil soluble lubricant additive package described above. Although the method may be employed with a wide variety of machines, it is believed that the method is especially suited for use with: gas engines, diesel engines, turbine engines, automatic transmissions, manual transmissions, hypoid axles, and gear boxes.

[0028] The present invention also includes machines lubricated by the lubricating oil described above. Although a wide variety of machines may be lubricated by the present inventive lubricating oil, it is preferred that the machine is selected from the group consisting of: gas engines, diesel engines, turbine engines, automatic transmissions, manual transmissions, hypoid axles, and gear boxes.

[0029] It is preferred that the lubricating oil additionally comprises at least one additive selected from the group consisting of: detergents, dispersants, antioxidants, friction modifiers, viscosity index improvers, and pour point depressants.

[0030] In accordance with the foregoing summary, the following presents a detailed description of the preferred embodiment of the invention that is currently considered to be the best mode.

[0031] The mineral oils useful in this invention can include but are not limited to all common mineral oil base stocks. This would include oils that are naphthenic or paraffinic in chemical structure. Oils that are refined by conventional methodology using acid, alkali, and clay or other agents such as aluminum chloride, or be extracted oils produced, for example, by solvent extraction with solvents such as phenol, sulfur dioxide, furfural, dichlorodiethyl ether, etc. They may be hydrotreated or hydrorefined, dewaxed by chilling or catalytic dewaxing processes, or hydrocracked. The mineral oil may be produced from natural crude sources or be composed of isomerized wax materials or residues of other refining processes. In one embodiment, the oil of lubricating viscosity is a hydrotreated, hydrocracked and/or iso-dewaxed mineral oil having a Viscosity Index (VI) of greater than 80, preferably greater than 90; greater than 90 volume % saturates and less than 0.03 wt. % sulfur.

[0032] Group II and Group III basestocks are also particularly suitable for use in the present invention, and are typically prepared from conventional feedstocks using a severe hydrogenation step to reduce the aromatic, sulfur and nitrogen content, followed by dewaxing, hydrofinishing, extraction and/or distillation steps to produce the finished base oil. Group II and III basestocks differ from conventional solvent refined Group I basestocks in that their sulfur, nitrogen and aromatic contents are very low. As a result, these base oils are compositionally very different from conventional solvent refined basestocks. The American Petroleum Institute has categorized these different basestock types as follows: Group I, >0.03 wt. % sulfur, and/or <90 vol% saturates, viscosity index between 80 and 120; Group II, ≤ 0.03 wt. % sulfur, and ≥ 90 vol% saturates, viscosity index between 80 and 120; Group III, ≤ 0.03 wt. % sulfur, and ≥ 90 vol% saturates, viscosity index > 120 ; Group IV, poly-alpha-olefins. Hydrotreated basestocks and catalytically dewaxed basestocks, because of their low sulfur and aromatics content, generally fall into the Group II and Group III categories.

[0033] There is no limitation as to the chemical composition of the various basestocks used in the present invention. For example, the proportions of aromatics, paraffinics, and naphthenics in the various Group I, Group II and Group III oils can vary substantially. The degree of refining and the source of the crude used to produce the oil generally determine this composition. In one embodiment, the base oil comprises a mineral oil having a VI of at least 110.

[0034] The lubricating oils may be derived from refined, re-refined oils, or mixtures thereof. Unrefined oils are obtained

directly from a natural source or synthetic source (e.g., coal, shale, or tar sands bitumen) without further purification or treatment. Examples of unrefined oils include shale oil obtained directly from a retorting operation, petroleum oil obtained directly from distillation, or an ester oil obtained directly from an esterification process, each of which is then used without further treatment. Refined oils are similar to the unrefined oils except that refined oils have been treated in one or more purification steps to improve one or more properties. Suitable purification techniques include distillation, hydrotreating, dewaxing, solvent extraction, acid or base extraction, filtration, and percolation, all of which are known to those skilled in the art. Re-refined oils are obtained by treating used oils in processes similar to those used to obtain the refined oils. These re-refined oils are also known as reclaimed or reprocessed oils and are often additionally processed by techniques for removal of spent additives and oil breakdown products:

VISCOSITY INDEX IMPROVERS

[0035] Viscosity index improvers impart high and low temperature operability to the lubricating oil and permit it to remain relatively viscous at elevated temperatures and also exhibit acceptable viscosity or fluidity at low temperatures. Viscosity index improvers are generally high molecular weight hydrocarbon polymers including polyesters. The viscosity index improvers may also be derivatized to include other properties or functions, such as the addition of dispersancy properties. These oil soluble viscosity modifying polymers will generally have number average molecular weights of from 10^3 to 10^6 , preferably 10^4 to 10^6 , as determined by gel permeation chromatography or osmometry.

[0036] The viscosity index improvers useful herein can include polymethacrylate-based ones, olefin copolymer-based ones, (e.g., isobutylene-based and ethylene-propylene copolymer based ones), polyalkyl styrene-based ones, hydrogenated styrene-butadiene copolymer-based ones, and styrene-maleic anhydride ester copolymer-based ones.

[0037] Representative examples of suitable viscosity index improvers are found in U.S. Pat. Nos. 5,075,383; 5,102,566; 5,139,688; 5,238,588; and 6,107,257. The above references are incorporated herein by reference.

POUR POINT DEPRESSANTS

[0038] Pour point depressants are used to improve low temperature properties of oilbased compositions. See, for example, page 8 of "Lubricant Additives" by C.V. Smalheer and R. Kennedy Smith (Lezius Hiles Co. publishers, Cleveland, Ohio, 1967). Examples of useful pour point depressants are polymethacrylates; polyacrylates; polyacrylamides; condensation products of haloparaffin waxes and aromatic compounds; vinyl carboxylate polymers; and ter-polymers of dialkylfumarates, vinyl esters of fatty acids and alkyl vinyl ethers. Pour point depressants are described in U.S. Patent Nos. 2,387,501; 2,015,748; 2,655,479; 1,815,022; 2,191,498; 2,666,746; 2,721,877; 2,721,878; and 3,250,715, which are herein incorporated by reference for their relevant disclosures.

DISPERSANTS

[0039] Dispersants used in the present invention may be ash-producing or ashless. Suitable dispersants for use herein can typically comprise amine, alcohol, amide, or ester polar moieties attached to the polymer backbone via a bridging group. The dispersant may be, for example, selected from oil-soluble salts, esters, amino-esters, amides, imides, and oxazolines of long chain hydrocarbon substituted mono- and dicarboxylic acids or their anhydrides; thiocarboxylate derivatives of chain hydrocarbons; long chain aliphatic hydrocarbons having a polyamine attached directly thereto; and Mannich condensation products formed by condensing a long chain substituted phenol with formaldehyde and polyalkylene polyamine, and Koch reaction products. The long chain aliphatic hydrocarbons can be polymers such as polyalkylenes, including, for example, polyisobutylene, polyethylene, polypropylene, and copolymers thereof and/or copolymers with other alpha-olefins. Typical PIB molecular weights useful herein can range from about 950 to 6000.

[0040] Representative examples of dispersants suitable for use in the present invention are found in U.S. Patent Nos. 5,075,383; 5,139,688; 5,238,588; and 6,107,257. Additional representative examples are found in U.S. Patent Application Publication No. 2001/0036906A1. The disclosures of the afore-mentioned references are incorporated herein by reference.

DETERGENTS

[0041] A detergent is an additive that reduces the formation of piston deposits, for example high-temperature varnish and lacquer deposits, in engines. Detergents typically possess acid-neutralizing properties and are capable of keeping finely divided solids in suspension. Metal detergents are used preferably for improving the acid-neutralizing properties, high-temperature detergency, and anti-wear properties of the resulting lubricating oil composition.

[0042] Detergents used herein may be any detergent used in lubricating oil formulations, and may be of the ash-producing or ashless variety. Detergents suitable for use in the present invention include all of the detergents customarily

used in lubricating oils, including metal detergents. Specific examples of metal detergents are those selected from alkali metal or alkaline earth metal sulfonates, alkali metal or alkaline earth metal phenates, and alkali metal or alkaline earth metal salicylates. In an embodiment, the lubricating oil formulation is essentially free of sulfurized phenate detergent.

[0043] Representative examples of suitable detergents useful in the present invention are found in U.S. Pat. Nos. 6,008,166. Additional representative examples of suitable detergents are found in U.S. Patent Application Nos. 2002/0142922A1, 2002/0004069A1, and 2002/0147115A1. The disclosures of the afore-mentioned references are incorporated by reference herein.

ANTIOXIDANTS

[0044] Useful antioxidant materials include oil soluble phenolic compounds, oil soluble sulfurized organic compounds, oil soluble amine antioxidants, oil soluble organo borates, oil soluble organo phosphites, oil soluble organo phosphates, oil soluble organo dithiophosphates and mixtures thereof. Such antioxidants can be metal free (that is, free of metals which are capable of generating sulfated ash), and therefore are most preferably ashless (having a sulfated ash value not greater than 1 wt. % SASH, as determined by ASTM D874).

[0045] Representative examples of suitable antioxidants useful in the present invention are found in U.S. Patent No. 5,102,566. Additional representative examples of suitable antioxidants useful in the present invention are found in U.S. Patent Application Publication No. 2001/0012821A1. The disclosures of the afore-mentioned references are incorporated by reference herein.

FRICTION MODIFIERS

[0046] Friction modifiers serve to impart the proper friction characteristics to lubricating oil compositions.

[0047] Friction modifiers include such compounds as aliphatic amines or ethoxylated aliphatic amines, aliphatic fatty acid amines, aliphatic carboxylic acids, aliphatic carboxylic esters of polyols such as glycerol esters of fatty acid as exemplified by glycerol phenate, aliphatic carboxylic ester-amides, aliphatic phosphonates, aliphatic phosphates, aliphatic thiophosphonates, aliphatic thiophosphates, etc., wherein the aliphatic group usually contains above about eight carbon atoms so as to render the compound suitably oil soluble. Also suitable are aliphatic substituted succinimides formed by reacting one or more aliphatic succinic acids or anhydrides with ammonia. Additionally suited for use in the present invention are friction modifiers containing molybdenum.

[0048] Representative examples of molybdenum-containing friction modifiers include those found in U.S. Patent Nos. 5,650,381; RE37,363E; 5,628,802; 4,889,647; 5,412,130; 4,786,423; 4,812,246; 5,137,647; 5,364,545; 5,840,672; 5,925,600; 5,962,377; 5,994,277; 6,017,858; 6,150,309; 6,174,842; 6,187,723; 6,268,316; European Patent Nos. EP 222 143 B1; EP 281 992 B1; EP 719 314 B1; EP 719 315 B1; EP 874 040 A1; EP 892 037 A1; EP 931 827 A1; EP 1 041 134 A1; EP 1 041 135 A1; EP 1 087 008 A1; EP 1 088 882 A1; EP; Japanese Patent No. JP 11035961; and International Publication Nos. WO 95/07965; WO 00/08120; WO 00/71649.

[0049] Representative examples of suitable friction modifiers are found in U.S. Pat. Nos. 3,933,659; 4,105,571; 3,779,928; 3,778,375; 3,852,205; 3,879,306; 3,932,290; 3,932,290; 4,028,258; 4,344,853; 5,102,566; 6,103,674; 6,174,842; 6,500,786; 6,500,786; and 6,509,303. Additional representative examples of suitable friction modifiers are found in U.S. Patent Application Publication No. 2002/0137636 A1. The disclosures of the above references are incorporated herein by reference.

EXAMPLES

[0050] The invention is illustrated by the following examples.

[0051] Lubricant compositions were prepared by blending the components present as indicated below. The results are shown in Tables 1 to 3 below. Filtration measurements are expressed either as a percentage or as a volume, as described above. A new 5 micron cellulose filter membrane was used for each test.

Table 1: Results for Kuwait Petroleum Company (KPC) stocks with and without a composition of the invention

Table 1	80W-90	85W-140	80W-90	80W-90	80W-90	80W-90	85W-90
HiTEC 343	4.4	4.4	4.4	4.4	4.4	-	-
HiTEC 637	1	1	-	-	1	-	-
Plexol 156	1	0.2	-	1	1	1	0.2
Composition of the invention*	0.2	0.2	-	-	-	-	-
New pack**	-	-	-	-	-	5.6	5.6
KPC 150BS	8	70.8	8	8	8	8	70.8
KPC 650	85.4	23.4	87.6	86.6	85.6	85.4	23.4
CETOP filtration, stage 2							
run 1 (%)	87.7	94.4	82.4	76.1	83.0	94.8	90.9
run 2 (%)	103.2	96.0	78.5	74.8	81.7	91.8	93.5
run 3 (%)	85.6	94.4	74.1	73.6	75.9	90.2	91.9
run 4 (%)	94.8	-	-	-	-	-	-
run 5 (%)	91.8	-	-	-	-	-	-
run 6 (%)	90.2	-	-	-	-	-	-
Average (%)	95.45	95.2	78.3	74.8	80.2	92.3	92.1

*A composition comprising 45 % by weight of a C₁₂₋₂₀ polyalkyl methacrylate polymer and 55 % by weight of a mineral carrier oil.

**The new pack is an additive pack consisting of a composition comprising 45 % by weight of a C₁₂₋₂₀ polyalkyl methacrylate polymer and 55 % by weight of a mineral carrier oil, HiTEC 637 and HiTEC 343 in the weight ratio of 1:5:22 respectively (equating to 0.2 %, 1 % and 4.4 % respectively of the total weight of the finished lubricating oil when the new pack accounts for 5.6 % of the total weight of the finished lubricating oil) which are blended together to produce the additive pack before being added to the other components present in each given test.

Table 2: Results for Repsol YPF stocks with and without a composition of the invention

	80W-90	85W-140	80W-90	85W-140	80W-90	85W-140	80W-90	85W-140	80W-90	85W-140
Repsol YPF 500SN	65	14	62.6	31	61.6	14	78.4	14	77.4	14
Repsol YPF 150BS	33	82.8	31	2	31	0.2	4.4	0.2	4.4	0.2
HiTEC 623	2	0.2	2	4.4	4.4	-	-	-	-	-
HiTEC 343	-	-	-	-	-	-	-	-	-	-
HiTEC 637	-	-	-	-	-	-	-	-	-	-
HiTEC 388	-	-	-	-	-	-	-	-	-	-
Composition of the invention*	-	-	-	-	-	-	-	-	-	-
CETOP filtration, stage 2										
run 1 (% [of 300ml] or volume in 2hr)	38.6	44 ml	294 ml	70.1	70.1	70 ml	60 ml	92.8	93.6	90.6
run 2 (% [of 300ml] or volume in 2hr)	33.3	42 ml	288 ml	70.7	70.7	64 ml	54 ml	95.5	95.1	90.8
run 3 (% [of 300ml] or volume in 2hr)	35.6	48 ml	286 ml	69.4	69.4	68 ml	58 ml	93.2	93.4	93.2
Average (%)	35.8	45 ml	289 ml	70.1	70.1	67 ml	57 ml	93.8	94.0	91.5

* A composition comprising 45 % by weight of a C₁₂₋₂₀ polyalkyl methacrylate polymer and 55 % by weight of a mineral carrier oil.

Table 3: Testing in other base stocks

HITEC 343	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
HITEC 637	1	1	1	1	1	1	1	1	1	1	1	1	1
HITEC 623	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Composition of the invention*	-	0.2	-	0.2	0.3	-	0.2	0.2	0.3	0.4	-	0.2	0.3
Shell HVI 170	10	10	-	-	-	-	-	-	-	-	-	-	-
Shell HVI 650	84.4	84.2	-	-	-	-	-	-	-	-	-	-	-
Esso 600SN	-	-	10	10	10	-	-	-	-	-	-	-	-
Esso BS 2500	-	-	84.4	84.2	84.1	-	-	-	-	-	-	-	-
Total 600SN	-	-	-	-	-	10	10	10	10	10	-	-	-
Total 150BS	-	-	-	-	-	84.4	84.2	84.1	84.0	-	-	-	-
Safor 450SN	-	-	-	-	-	-	-	-	-	10	10	10	10
Safor 150BS	-	-	-	-	-	-	-	-	-	84.4	84.2	84.1	84.1
Total	100	100	100	100	100	100	100	100	100	100	100	100	100
CETOP filtration													
run 1 (% or vol. in 2 hrs)	91.5	94.7	69.3	93.6	98.9	128ml	78.5	94.8	100.9	59.1	83.9	95.2	95.2
run 2 (% or vol. in 2 hrs)	97	102.1	70.6	98.1	99.6	130ml	81	96.0	97.7	61.3	82.4	95.5	95.5
run 3 (% or vol. in 2 hrs)	97.3	92.6	69.4	97.9	100.7	118ml	79.9	94.7	94.0	61.6	85.1	96.4	96.4

*A composition comprising 45 % by weight of a C₁₂₋₂₀ polyalkyl methacrylate polymer and 55 % by weight of a mineral carrier oil.

[0052] The results exemplified in the Tables 1 to 3 illustrate the significant improvement in filtration performance exhibited by blends that comprise a C₁₂₋₂₀ polyalkyl methacrylate polymer at the appropriate concentrations. In conjunction with Table 5 it is of note that the Shell base stocks meet the specification by Scania without the addition of a C₁₂₋₂₀ polyalkyl methacrylate polymer at the appropriate concentrations. This is because the Shell base stock is filtered to remove the wax during the manufacturing process. In any case, the addition to this base stock of a C₁₂₋₂₀ polyalkyl methacrylate polymer at the appropriate concentrations did not result in any detrimental effect to the filterability of the finished oil blend and the finished lubricating oil resulting from the addition to the Shell base stock of a C₁₂₋₂₀ polyalkyl methacrylate polymer at the appropriate concentrations was shown to meet the specification by Scania (STO 1:0).

[0053] The properties of certain components (as used in the above experiments and in the industry in general) are as follows:

	Property
Plexol 156	pour point depressant
HITEC 623	pour point depressant
HITEC 343	gear additive package
HITEC 637	Dispersant
HITEC 388	fully formulated gear package

Claims

- Use of a C₁₂₋₂₀ polyalkyl methacrylate polymer as a lubricating oil additive such that the C₁₂₋₂₀ polyalkyl methacrylate polymer accounts for 0.1 to 0.3 % by weight of the finished lubricating oil, which use comprises the addition of said C₁₂₋₂₀ polyalkyl methacrylate polymer to a lubricating oil based on mineral oil to improve the filtration of said lubricating oil based on mineral oil.
- Use according to claim 1 wherein the lubricating oil based on mineral oil is a gear oil.
- Use according to claim 1 or 2 wherein the mean CETOP filtration stage 2 test value of the finished lubricating oil (the oil resulting from said use) is over 90 %.
- Use according to claim 3 wherein the finished lubricating oil (the oil resulting from said use) meets the specification by Scania (STO 1:0).
- Use according to any one of claims 1 to 4 wherein the C₁₂₋₂₀ polyalkyl methacrylate polymer accounts for 0.1 or 0.2 % by weight of the finished lubricating oil.
- Use according to any one of the preceding claims of a composition comprising the C₁₂₋₂₀ polyalkyl methacrylate polymer.
- Use according to claim 6 wherein the composition comprises about 45 % by weight of the C₁₂₋₂₀ polyalkyl methacrylate polymer and about 55 % by weight of a mineral carrier oil.
- Use according to claim 7 wherein the composition has a viscosity of 800 mm²/s (ASTM D4052) at 100 °C.
- Use according to any one of the preceding claims wherein the lubricating oil based on mineral oil has a viscosity of 80W-90 or 85W-140.
- Use according to any one of claims 1 to 8 wherein the lubricating oil based on mineral oil is for automotive or industrial applications.
- Use according to any one of the preceding claims wherein the lubricating oil based on mineral oil is a part synthetic

base stock.

12. Use according to any one of the preceding claims wherein the lubricating oil based on mineral oil comprises bright-stock.

13. Use according to any one of the preceding claims wherein the lubricating oil based on mineral oil is Kuwait Petroleum Company, Repsol YPF, Total, Esso or SAFOR base stock.

14. Use according to any one of the preceding claims wherein the lubricating oil based on mineral oil and/or the finished lubricating oil comprises a further additive, which further additive is added to the lubricating oil based on mineral oil or the finished lubricating oil prior to, simultaneously with or subsequently to the composition comprising a C₁₂₋₂₀ polyalkyl methacrylate polymer in a mineral carrier oil.

15. Use according to any one of the preceding claims wherein the lubricating oil based on mineral oil is a formulated gear lubricant composition.

16. A finished lubricating oil resulting from a use as defined in any one of claims 1 to 15.

17. A method of lubricating the metal surface of a gear or axle comprising applying to the metal surface a finished lubricating oil as defined in claim 16.

18. A method according to claim 17 wherein the method comprises adding a finished lubricating oil as defined in claim 16 to a transmission or axle and operating the transmission or axle.

19. A gear or axle which has been lubricated in a method according to claim 17 or 18.

20. A composition comprising a C₁₂₋₂₀ polyalkyl methacrylate polymer in a mineral carrier oil for use as defined in any one of claims 1 to 15.

21. A gear additive package comprising a composition as defined in claim 20.



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 4411

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 955 405 A (LIESEN ET AL) 21 September 1999 (1999-09-21) * abstract * * column 1, lines 6-10 * * column 2, lines 16-29 * * column 2, line 61 - column 3, line 7 * * column 5, line 60 - column 6, line 44 * * column 8, lines 4-8 * -----	1-21	C10M169/04 C10M145/14 B60K17/00
X	US 5 368 761 A (GORE ET AL) 29 November 1994 (1994-11-29) * abstract * * column 1, lines 13-33 * * column 1, line 44 - column 2, line 55 * * column 2, line 66 - column 3, line 11 * * column 7, lines 1-33 * * claims 1,9,10,19,20 * -----	1,3-14, 16,20,21	
X	US 5 043 087 A (PENNEWISS ET AL) 27 August 1991 (1991-08-27) * abstract * * column 1, lines 11-46 * * column 2, line 44 - column 3, line 60 * * column 5, line 55 - column 6, line 15 * * column 6, line 50 - column 7, line 5 * * column 7, lines 34-60 * * column 8, lines 27-54 * * tables 1-3 * -----	1-21	TECHNICAL FIELDS SEARCHED (IPC) C10M B60K
X	US 4 822 508 A (PENNEWISS ET AL) 18 April 1989 (1989-04-18) * column 2, lines 3-49 * * column 3, lines 17-21 * * column 4, lines 38-43 * * column 5, line 16 - column 8, line 43 * ----- -/--	1-21	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 November 2005	Examiner Perakis, N
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

2
EPO FORM 1503 03.02 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 4411

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 843 874 A (MACPHERSON ET AL) 1 December 1998 (1998-12-01) * abstract * * column 1, lines 11-34 * * column 3, line 46 - column 4, line 43 * * column 5, lines 40-44 * * column 6, lines 34-48 * * column 6, line 66 - column 7, line 23 * * column 8, lines 27-44 * * column 9, lines 20-46 * * column 9, lines 53-61 * * column 10, lines 1-31 * * column 17, lines 23-32 * * claims 1,2,15 * -----	1-21	
			TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 November 2005	Examiner Perakis, N
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

2

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 25 4411

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-11-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5955405 A	21-09-1999	AU 3687899 A	02-03-2000
		BR 9903570 A	31-10-2000
		CA 2276900 A1	10-02-2000
		CN 1244540 A	16-02-2000
		DE 69918615 D1	19-08-2004
		DE 69918615 T2	21-07-2005
		EP 0979834 A2	16-02-2000
		JP 2000063439 A	29-02-2000
		KR 2000017033 A	25-03-2000
		SG 81290 A1	19-06-2001
US 5368761 A	29-11-1994	AT 194165 T	15-07-2000
		BR 9401621 A	22-11-1994
		CA 2112317 A1	31-10-1994
		CN 1094438 A	02-11-1994
		CZ 9400962 A3	16-11-1994
		DE 69425019 D1	03-08-2000
		DE 69425019 T2	22-02-2001
		EP 0623665 A2	09-11-1994
		FI 941858 A	31-10-1994
		HU 69301 A2	28-09-1995
		JP 7048421 A	21-02-1995
		NO 941447 A	31-10-1994
		US 5312884 A	17-05-1994
		ZA 9402758 A	09-11-1994
US 5043087 A	27-08-1991	BE 906116 A1	16-04-1987
		DE 3613992 A1	29-10-1987
		FR 2601029 A1	08-01-1988
		GB 2189495 A	28-10-1987
		IT 1208403 B	12-06-1989
		JP 62257986 A	10-11-1987
		NL 8700962 A	16-11-1987
US 4822508 A	18-04-1989	CA 1288411 C	03-09-1991
		DE 3544061 A1	19-06-1987
		EP 0225598 A2	16-06-1987
		JP 2509199 B2	19-06-1996
		JP 62141096 A	24-06-1987
US 5843874 A	01-12-1998	EP 0812901 A2	17-12-1997

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82